The "new_MAD-Based-Model" for AGS.

The Model includes the Helical Magnets for polarized proton beam operations

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Aim of this presentation

To show that the "new-MAD-Based-Model" for AGS
Should be further improved

WHY???

- A "good" Model will minimize the setup time of AGS for polarized protons beam delivery in RHIC

- Will allow further improvements in the optics of AGS.

| Device	Name	Location	
Quad	Q1	SS_A17	
Quad	Q2	SS_A19	
Cold Helix	CHM	SS_A20	
Quad	Q3	SS_B1	
Quad	Q4	SS_B3	
Quad	Q5	SS_E17	
Quad	Q6	SS_E19	
Warm Helix	WHM	SS_E20	
Quad	Q7	SS_F1	
Local Beam Bump	A20 Cold Helical Magnet Only		
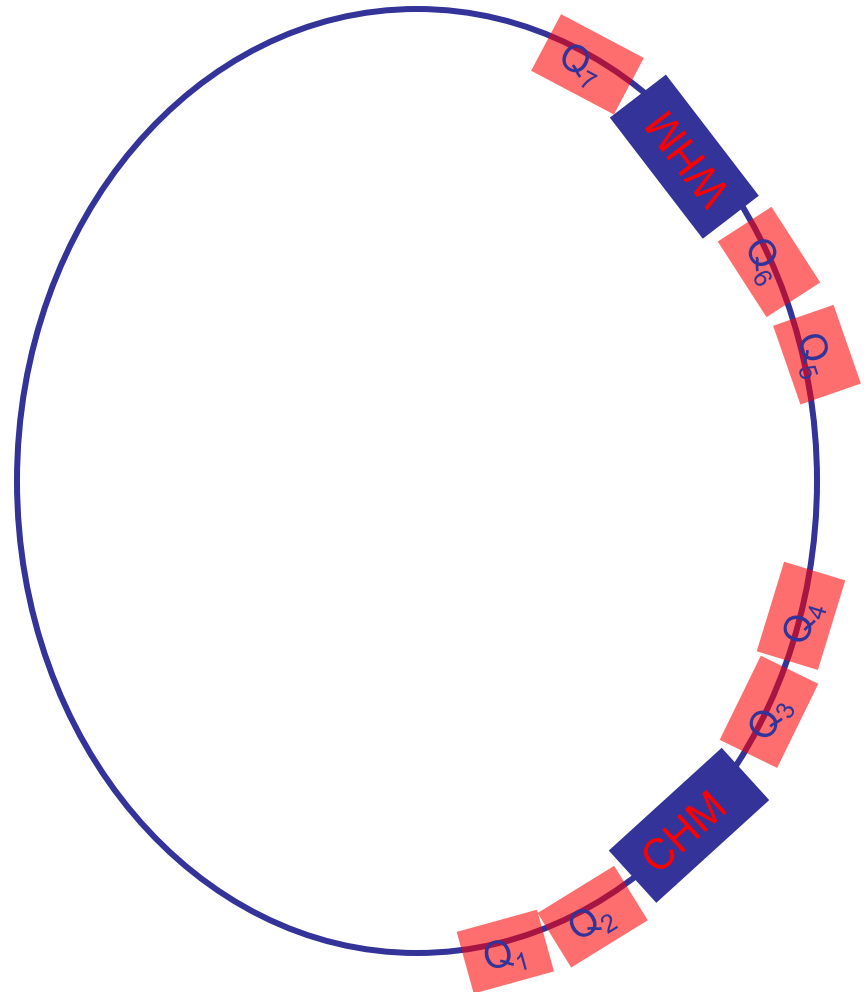
Again; Why a "new_MAD-Model"?
The "old_MAD-Model" is not good enough?

- ## The Helical Magnets do affect the beam optics.

  - Helical magnets Focus the beam in both, the Horizontal and Vertical planes

  - Introduce some transverse linear beam coupling.

  - The beam path in the Helical Magnet is almost a helix which adds 2-3 mm in the path length.

  - Introduce "some" higher order magnetic multipoles.

The 'New MAD_Based_Model" includes these devices.

Device	Name	Location	Model
Quad	Q1	SS_A17	Quad
Quad	Q2	SS_A19	Quad
Cold Helix	CHM	SS_A20	R_Matrix
Quad	Q3	SS_B1	Quad
Quad	Q4	SS_B3	Quad
Quad	Q5	SS_E17	Quad
Quad	Q6	SS_E19	Quad
Warm Helix	WHM	SS_E20	R_matrix
Quad	Q7	SS_F1	Quad
Local Beam Bump	A20 Cold Helical Magnet Only		Kick
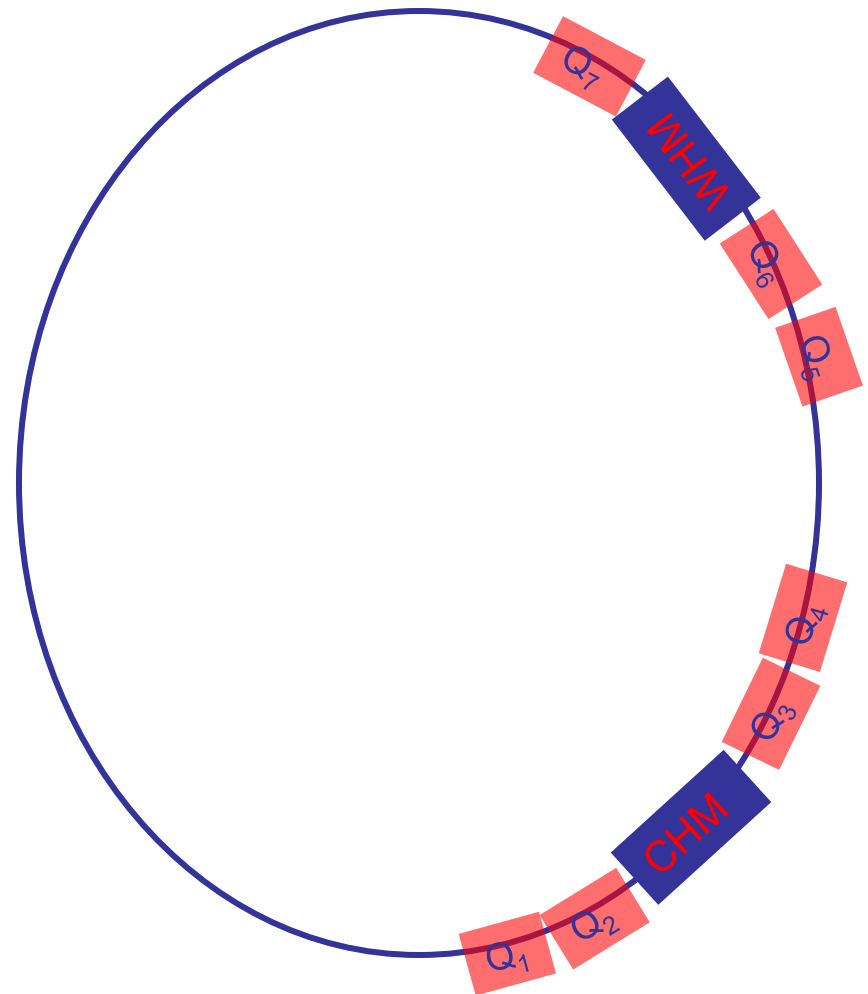
Constraints of the "new MAD_Based Model" for the AGS during beam "Acceleration": .

– Horizontal and Vertical tunes are constraint.

– Minimize the beam size during the Magnet cycle especially at Injection Energies.

How do we test the "new MAD_Based Model"?

- Compare Experimentally Measured Quantities with those as Calculated from the "new MAD_Model".
  - Q_x, Q_y as a function of R_{ave} (Average Radius of the circulating beam).
  - Dispersion functions (η_x, η_y) of the AGS at the location of the BPM's.
  - Beta function (β_x, β_y) of the AGS at convenient the locations along the ring.
  - Measurements to test beam coupling

Example:
Measurements on AGS_User#1 Warm and Cold Helical magnets
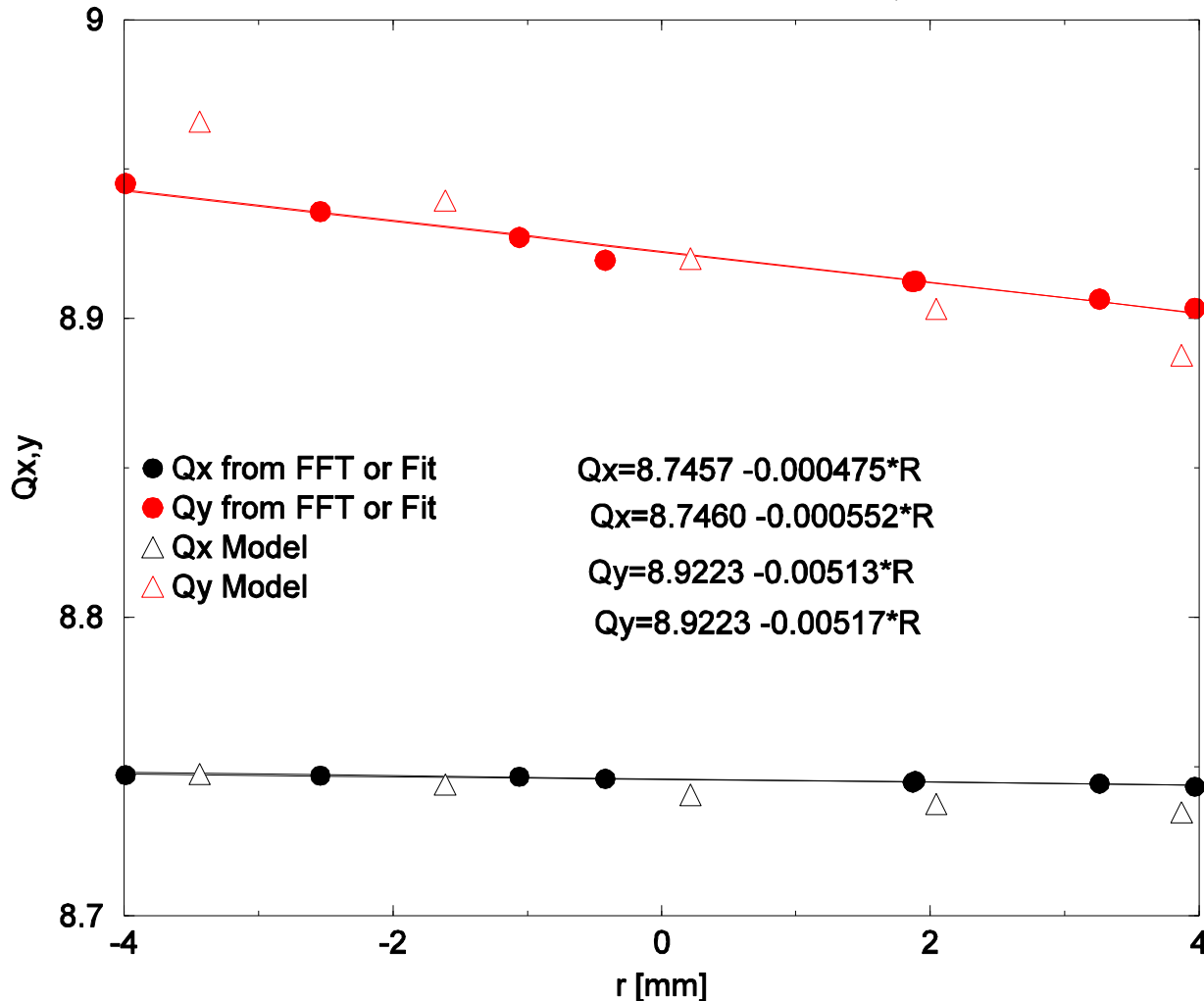May 29 2009 Booster-AGS-Log#295 (AGS at Injection)

- Q1,Q2 as a function of R_{ave}

- Dispersion measurements at the location BPM's

- Beta functions at the location of the Compensation Quads

Chromaticity
AGS User#1 Warm/Cold Helices at Gγ=4.5

Qx,y Tunes vs Ave Beam Radius

AGS User1 Cold Warm Snks AGS at Injection

- Qx from FFT or Fit
- Qy from FFT or Fit
△ Qx Model
△ Qy Model

Qx=8.7457 -0.000475*R
Qx=8.7460 -0.000552*R
Qy=8.9223 -0.00513*R
Qy=8.9223 -0.00517*R

Comments:

a) The Warm and Cold Helices are modeled after Alfredo's matrices.

b) Error in $Q_{x,y}$ is much smaller of the size of the points.

c) "FFT" and "Fit" in very good agreement.

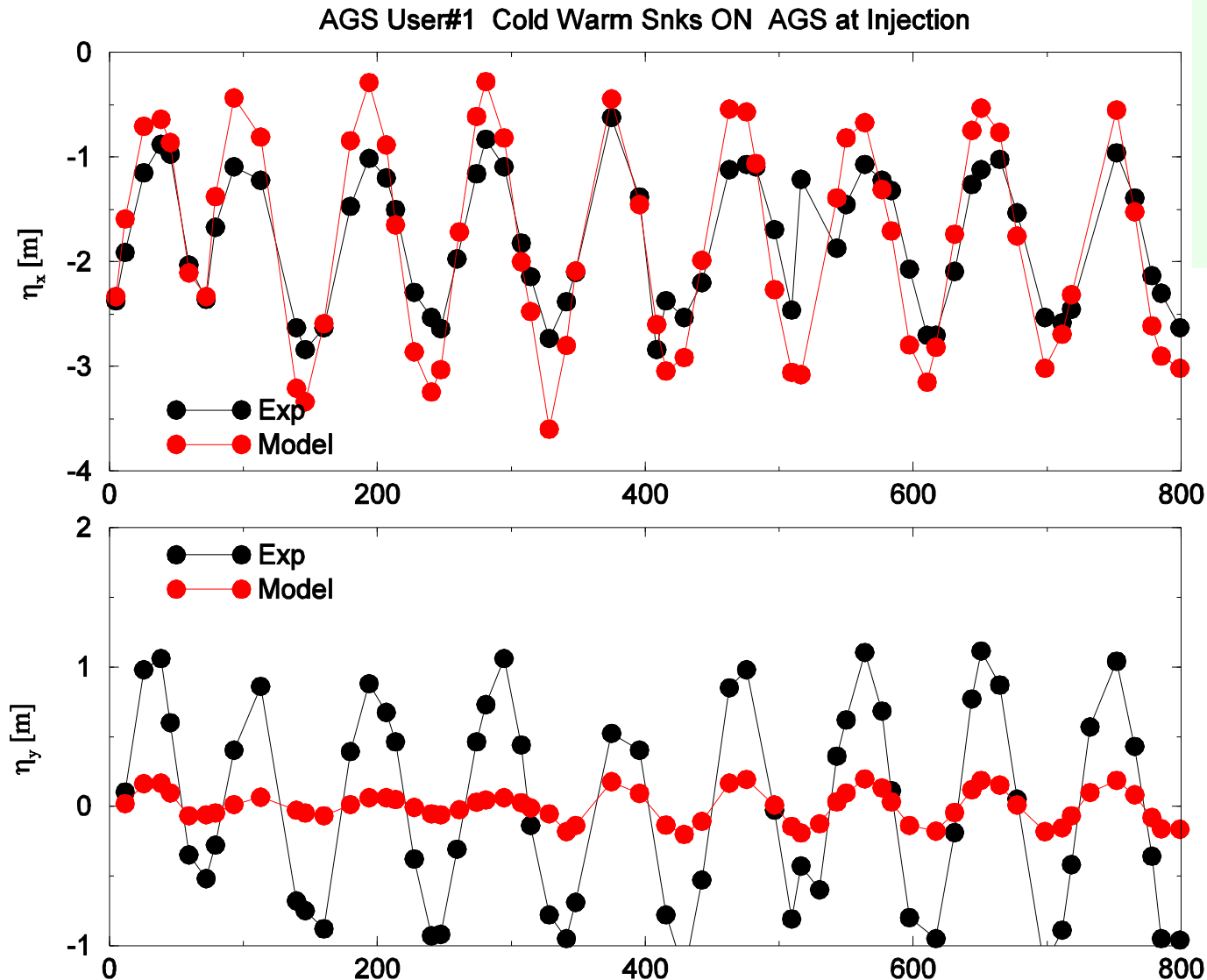Conclusions:

Measured Chromaticity not in agreement with the modeled one.

Dispersion (η_x,η_y) at BPM's at R_{beam}=0.0 mm
AGS User#1 Warm/Cold Helices at Gγ=4.5

Comments:

a) The Warm and Cold Helices are modeled after Alfredo's R_matrices.

b) Error in $\eta_{x,y}$ is the size of the points.

AGS User#1 Cold Warm Snks ON AGS at Injection

Conclusions:

Measured Coupling stronger than the Modeled one.

Beta values at QA17 and QE17
AGS User#1 Warm/Cold Helices at Gγ=4.5

Comments:

Relative Error in measuring $\beta_{x,y}$ is ±30%

Conclusions:

No Good agreement with model

$\beta_{x,y}$ vs. Delta_I of QA17

AGS User#1 Warm Cold Snks ON Gγ=4.5

● β_x FFT at Delta_I=0 14.7 [m]
■ β_x Fit
● β_y FFT at Delta_I=0   3.1 [m]
■ β_y Fit
△ β_x Model
△ β_y Model

$\beta_{x,y}$ [m]

Delat_I [A]

$\beta_{x,y}$ vs. Δ_I of QE17

AGS User#1 Warm Cold Snks ON Gγ=4.5

● β_x FFT at Delta_I=0   43.3 [m]
■ β_x Fit
● β_y FFT at Delta_I=0   16.2 [m]
■ β_y Fit
△ β_x Model
△ β_y Model

$\beta_{x,y}$ [m]

Δ_I [A]
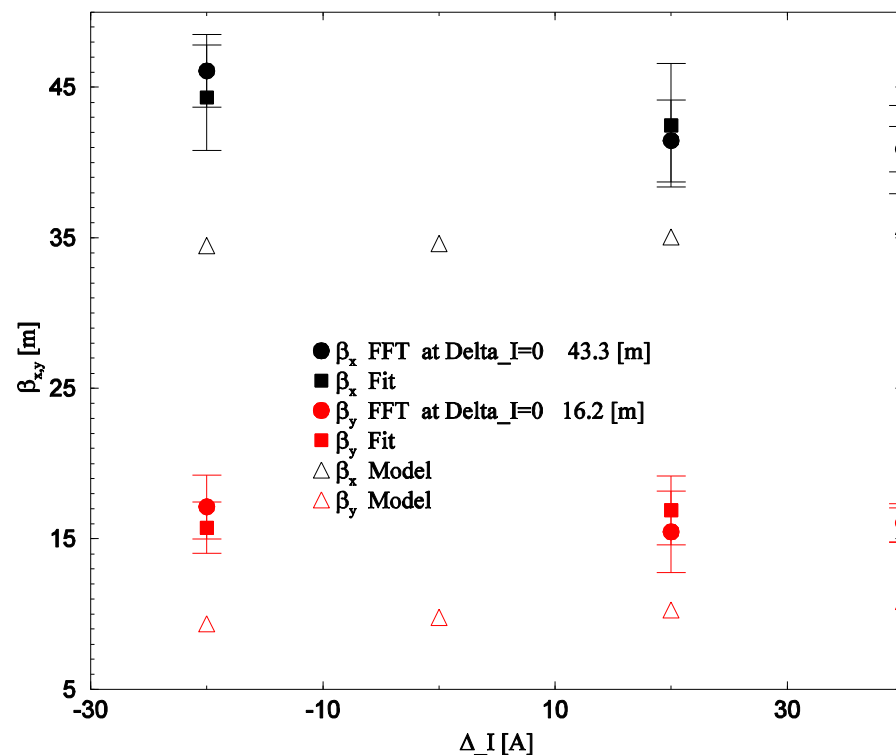
Conclusions from the:
Measurements on AGS_User#1 Warm and Cold Helical magnets
May 29 2009 Booster-AGS-Log#295 (AGS at Injection)

- Measurements vs. Calculations described below;

  - Q1,Q2 as a function of R_{ave} ;   Not good agreement
  - Dispersion measurements at the location BPM's   Not good agreement
  - Beta functions at the location of the Comp. Quads   Not good agreement

- The quantities generated by the "new-AGS-Model" do not agree well with the measured ones.

There are many more measurements "done" on AGS_User#3. The data from these measurements have been analyzed or are in the process to be analyzed.

This inability of the "new AGS-Model" to agree with the measured quantities raises the Questions;

- What devices in AGS are not modeled correctly to account for this discrepancy?

  - Cold helical Magnet ?
  - Warm helical Magnet ?
  - Both Cold and Warm ?
  - Or is it that the "Bare AGS" bares some responsibility for the disagreement?

From the data of the measurements we have analyzed till now;
We can conclude;

- The MAD-Model of the Bare AGS needs to be modified "a bit" to be in agreements with the measured quantities.

- The Matrices that describe the Cold and Warm Helical magnets have to be modified "a bit".

- At these fields at which the Helical Magnets are operating; The magnets are simply "Helical" and easy to work with; by no means these magnets are "Hell ical".

The End